

OFFICE OF SPACE SCIENCE (Code S)

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The total Fiscal Year 2001 budget request for NASA's Office of Space Science is \$2,398.8 million - about a 10 percent increase over FY 2000.

SPACE SCIENCE OVERVIEW

With NASA's FY 2001 budget, the Space Science Enterprise is poised to enter the new millennium with a solid foundation upon which to build as well as expanded new capabilities to explore the farthest reaches of the Universe and the solar system.

The Office of Space Science is looking for answers to the following questions:

- How did the Universe, galaxies, stars, and planets form and evolve?
- How can exploration of the Universe and our solar system revolutionize our understanding of physics, chemistry, and biology?
- Are there Earth-like planets beyond our solar system?
- Does life in any form, however simple or complex, carbon-based or other, exist elsewhere than on planet Earth?

The four long-term goals of the Space Science Enterprise are:

- Establish a virtual presence throughout the solar system and probe deeper into the mysteries of the Universe and life on Earth and beyond -- a goal focused on the fundamental science we will pursue;
- Pursue space science programs that enable, and are enabled by, future human exploration beyond low-Earth orbit -- a goal exploiting the synergy with the human exploration of space;
- Develop and utilize revolutionary technologies for missions impossible in prior decades -- a goal recognizing the enabling character of technology; and
- Contribute measurably to achieving the science, mathematics, and technology education goals of our nation, and share widely the excitement and inspiration of our missions and discoveries -- a goal reflecting our commitment to education and public outreach.

"Living With A Star" Initiative

The President's FY 2001 budget request features a significant new initiative in the Space Science Enterprise. To better study solar variability and understand its effects on humanity, NASA is starting a program called "Living With A Star," a set of missions and enhancements to current programs which will eventually encompass a number of spacecraft and systems. Living With A Star also will pursue partnerships with other

Federal agencies (USAF, NOAA, NSF) that are concerned with the effects of the Sun on the Earth. The goal is to provide an exciting new capability for understanding, and ultimately predicting, "solar weather", which affects Earth.

The budget includes a \$20 million augmentation for the "Living With a Star" Initiative in FY 2001.

Our Sun is a tremendously powerful, violent, and variable star like many we can see in the night sky. It's a source of energy and radiation that not only makes life possible, but also greatly affects the Earth's space environment and can affect many of the advanced technologies we have become so dependent on for everything from economic livelihood to national defense.

In fact, as civilization becomes more technically advanced and expands into space, both physically and economically, we are finding that Solar variability can affect an increasing number of areas: civilian and military space systems, human space flight, electric power grids, GPS signals, high-frequency radio communications, long-range radar, microelectronics and humans in high-altitude aircraft, and terrestrial climate.

The Living with A Star initiative will:

- * Observe the entire Sun simultaneously using a few well-positioned spacecraft, including Solar Sentinel spacecraft, which will observe the side of the Sun away from the Earth -- the first spacecraft capable of doing so.
 - * The Sentinels will work in combination with other spacecraft to track solar storm regions over the entire solar surface as it rotates, something which has never before been possible.
- * Track solar storm regions both above and below the solar surface for the first time, using an advanced spacecraft called the Solar Dynamic Observatory (SDO).
 - * SDO will also probe the interior of the Sun to help us understand the source of solar variability.
- * Use the Sentinels, the SDO, and dozens of low cost micro-satellites in critical regions around Earth (the Geospace Dynamics Network) to track Earth-directed solar mass ejections and their impact on the Earth's space environment.
 - * The goal is to understand how ejected solar material travels through space toward Earth and affects the Earth's space environment and outer atmosphere, so we can predict which solar ejections will affect us and how much.
- * Use one of the most intriguing and far-reaching technologies currently under development: large Solar sails.
 - * The sails on these new satellites will be somewhat like those used on sailing ships for propulsion, but will use the energy in sunlight, rather than wind, to get to their stationary positions above the poles of the Earth and in polar orbit about the Sun. These positions and orbits are difficult to achieve using the type of rocket thrusters we use today.

- * Miniaturize spacecraft and instruments, to enable very small and less expensive spacecraft so that we can put up numerous "space buoys" much as we now have ocean buoys.
- * The Geospace Dynamics Network will employ a fleet of such low-cost, small satellites (nanosats and microsats) to probe the Earth's upper atmosphere and space environment and their response to solar storms.

CURRENT STATUS

Last year, NASA's Space Science enterprise experienced a number of tremendous successes and, unfortunately, a few failures. NASA's Space Science spacecraft continue to generate a stream of scientific discoveries and dramatic images, which received widespread media coverage. Recent highlights include results from the Hubble Space Telescope, Galileo, Mars Global Surveyor, Chandra, and the Compton Gamma-Ray Observatory. Results from these spacecraft, and many others, have been extremely scientifically productive as well as in the news on a regular basis. Top highlights include:

- * **EXPANDING UNIVERSE.** Hubble scientists achieved one of the three major goals set for the telescope when it was launched in 1990 when they measured how fast the universe is expanding, a value essential to determining the age and size of the universe.
- * **EXTRASOLAR PLANETS DISCOVERED.** A team of NASA-supported astronomers searching the galaxy with powerful telescopic instruments found six new planets orbiting nearby stars, bringing the total of known planets outside the solar system to 28, all of which have been detected within the last five years.
- * **LATEST FROM MARS.** Mars Global Surveyor Provided the First Global 3-D Map of Mars. An impact basin deep enough to swallow Mount Everest and surprising slopes in Valles Marineris highlight a global map of Mars that will influence scientific understanding of the red planet for years.
- * **IMAGES OF A MASSIVE COSMIC EXPLOSION.** Alerted by NASA's Compton Gamma Ray Observatory, astronomers raced the clock to take the first-ever optical images of one of the most powerful explosions in the Universe -- a gamma ray burst -- just as it was occurring on January 23, 1999.
- * **CHANDRA EXPLORES THE CRAB NEBULA.** In July, the Space Shuttle Columbia successfully deployed the Chandra X-Ray Observatory in orbit. After barely two months in space, Chandra took a stunning image of the Crab Nebula, the most intensively studied object beyond our Solar System, and revealed something never seen before: a brilliant ring around the nebula's heart.

- * **SOLAR WIND AND THE AURORAL DISPLAY AT THE NORTH POLE.** From May 10-12, 1999, several NASA spacecraft observed that the solar wind virtually disappeared in the most drastic and longest-lasting decrease ever seen.
- * **HUBBLE GIVEN NEW NAVIGATION EQUIPMENT AND IMPROVED VISION OF THE UNIVERSE.** The crew of the Space Shuttle Discovery replaced Hubble's gyros, made numerous improvements to battery power and guidance systems, and gave it new outer layers of thermal protection, making it better than new. The Hubble was released into space on Christmas Day and has returned to operations.

SPACE SCIENCE PROGRAMS

Space Infrared Telescope Facility (SIRTF) \$117.6 million

The purpose of the Space Infrared Telescope Facility (SIRTF) mission is to explore the nature of the cosmos through the unique windows available in the infrared portion of the electromagnetic spectrum. These windows allow infrared observations to explore the cold Universe by looking at heat radiation from objects which are too cool to radiate at optical and ultraviolet wavelengths; to explore the hidden Universe by penetrating into dusty regions which are too opaque for exploration in the other spectral bands; and to explore the distant Universe by virtue of the cosmic expansion, which shifts the ultraviolet and visible radiation from distant sources into the infrared spectral region. To exploit these windows requires the full capability of a cryogenically-cooled telescope, limited in sensitivity only by the faint infrared glow of the interplanetary dust.

SIRTF completed its spacecraft bus structure on schedule in May 1999. Delivery of all of the instrument focal plane arrays was completed on schedule in September 1999. The flight model of the cryostat was completed on schedule in October 1999. Delivery of the instruments will be completed by April 2000 to enable integration of the Cryo/Telescope Assembly late in the fiscal year. The spacecraft and the CTA will be completed and ready for integration in the second quarter of FY 2001.

Hubble Space Telescope Development \$168.1 million

The goal of the Hubble Space Telescope (HST) development activity is to provide new flight hardware, subsystems and instruments to extend the telescope's operational life and to enhance its capabilities. HST was launched in April 1990 aboard the Space Shuttle. It is the first and flagship mission of NASA's Great Observatories program, and it is designed to complement the wavelength capabilities of the other spacecraft in the program (Compton Gamma Ray Observatory (CGRO), Chandra X-ray Observatory (CXO), and Space Infrared Telescope Facility (SIRTF)). HST is the only one of those observatories that can be serviced and upgraded on orbit. HST is a 2.4-meter telescope capable of performing observations at visible, near-ultraviolet, and near-infrared wavelengths. This program is a joint endeavor of NASA and the European Space Agency (ESA), which provided the faint object camera and the HST's solar arrays. HST is a general observer facility with a worldwide user community.

HST Servicing Mission 3A was successfully completed, and HST has returned to science operations at the forefront of astronomical research. All plans for Servicing Mission 3B are on track, with the mission currently scheduled for May 2001. Testing of the Advanced Camera for Surveys (ACS) science instrument, the replacement solar arrays, and other components is ongoing. Deliveries of completed units to GSFC for final testing will begin in the latter half of FY 2000.

In preparing for Servicing Mission 4, the initial design, fabrication and assembly of the Cosmic Origins Spectrograph will be completed early in 2000, after which it will enter a period of integration and testing extending through FY 2001. Wide Field Camera 3 initial design, fabrication and assembly have begun, and are expected to continue through late FY 2001. The mission is currently scheduled for June 2003.

Relativity Mission (Gravity Probe-B) \$13.8 million

The purpose of the Relativity Mission (also known as Gravity Probe-B) is to verify Einstein's theory of general relativity, the most accepted theory of gravitation and of the large-scale structure of the Universe. An experiment is needed to explore more precisely the predictions of the theory in two areas: (1) a measurement of the "dragging of space" by rotating matter; and (2) a measurement of space-time curvature known as the "geodetic effect." The dragging of space has never been measured, and the geodetic effect needs to be measured more precisely. Whether the experiment confirms or contradicts Einstein's theory, its results will be of the highest scientific importance.

Gravity Probe-B is proceeding toward a September 2001 launch date. The program had previously been attempting to achieve an earlier launch date, but a failure in the flight probe discovered during payload verification has eliminated that possibility. The spacecraft is manifested to launch aboard a Delta II.

In FY 2000, the program expects to repair the flight probe, reinstall the flight probe into the flight dewar, complete payload verification testing, and deliver the payload for integration with the spacecraft.

We are expecting a significant cost growth in FY 2001 as a result of the delay from the baseline launch in October 2000 to September 2001. The cost growth is driven by schedule and manpower needs associated with resolving the technical issues that caused the delay. To prevent or mitigate further schedule delays, resources have been shifted from the spacecraft effort, which is well ahead of critical path, to the probe repair and payload integration and test efforts, which are on the critical path. NASA is continuing to review Relativity Mission funding and schedule requirements.

Stratospheric Observatory For Infrared Astronomy (SOFIA) \$33.9 Million

The primary objective of the SOFIA program is to make fundamental scientific discoveries and contribute to our understanding of the Universe through gathering and rigorous analysis and distribution of unique infrared and submillimeter wavelength

astrophysical data. SOFIA will extend the range of astrophysical observations significantly beyond that of previous infrared airborne observatories through increases in sensitivity and resolution.

In FY 2000, the German Telescope Assembly and U.S. systems critical design reviews (CDRs) will be completed, and major aspects of the structural modification of the 747 SP aircraft will be underway. Our German partners should also be far along in the fabrication and test of all major elements of the Telescope Assembly.

In FY 2001, it is anticipated that the structural modification of the aircraft will be completed. In Germany, all elements of the Telescope Assembly hardware should complete fabrication and subsystem testing, in preparation for installation into the SOFIA aircraft early in FY 2002, at which point overall Observatory-level integration, test, and verification will commence. Initial SOFIA science operations are now planned to start in November 2002.

Payload and Instrument Development \$7.1 Million

Payload and Instrument Development supports development of hardware to be used on international satellites or on Shuttle missions. International collaborative programs offer opportunities to leverage U.S. investments, obtaining scientific data at a relatively low cost. Shuttle missions utilize the unique capabilities of the Shuttle to perform scientific experiments that do not require the extended operations provided by free-flying spacecraft. Payload and Instrument Development supports investigations in the Astronomical Search for Origins, Sun-Earth Connections, Structure and Evolution of the Universe, and Exploration of the Solar System science themes.

Explorer Program Development \$138.8 million

The goal of the Explorer Program is to accomplish frequent, high-quality space science investigations utilizing innovative, streamlined, and efficient management approaches. It seeks to substantially reduce mission cost through commitment to, and control of, design, development, and operations costs, as well as to reduce cost and improve performance through the use of new technology. Finally, it seeks to enhance public awareness of, and appreciation for, space science and to incorporate educational and public outreach activities as integral parts of space science investigations.

Explorer missions are categorized by size, starting with the largest, Delta-class, moving down through the Medium-class (MIDEX), the Small-class (SMEX) and the University-class (UNEX) missions. Funding for Explorer launch services and mission studies is also provided within the Explorer budget.

Three missions are targeted for launch in FY 2001: Microwave Anisotropy Probe (MAP) in November 2000, Cooperative Astrophysics & Technology Satellite (CATSAT) in July 2001, and Galaxy Evolution Explorer (GALEX) in September 2001. Full-scale spacecraft and instrument development for the Swift and Full-Sky Astrometric Mapping Explorer (FAME) missions will continue throughout FY 2001. Mission studies and

spacecraft and instrument development for the Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) and Inner Magnetosphere Explorer (IMEX) missions will continue through FY 2001, in preparation for launches in the 3rd and 4th quarters of FY 2002. Development efforts for the Two Wide-Angle Imaging Neutral Atom Spectrometers (TWINS) mission will continue throughout FY 2001; TWIN-A will launch in late FY 2003 and TWIN-B will launch in the 2nd Quarter of FY 2004. Step-2 selections for the SMEX 8 and 9 missions will be made in the 3rd quarter of FY 2001. Announcements of Opportunity for both UNEX and MIDEX missions will be released in FY 2001.

Discovery Program Development \$196.8 million

The Discovery program provides frequent access to space for small planetary missions that will perform high-quality scientific investigations. The program responds to the need for low-cost planetary missions with short development schedules. The cost of building a Discovery mission spacecraft must not exceed \$150 million (FY 1992 dollars), and the mission must launch within three years from start of development. The program also seeks to enhance public awareness of, and appreciation for, space exploration and to provide educational opportunities.

Beginning in FY 2001, a new element has been added to the Discovery Program: Discovery Micromissions. Discovery Micromissions will employ new capabilities such as secondary launches, small spacecraft buses and new launch vehicles to conduct inexpensive solar system science.

The Stardust mission was launched on a Med-Lite version of the Delta II expendable launch vehicle in February 1999, to rendezvous with the comet Wild 2 in January 2004 and return the samples to Earth in January 2006.

The Genesis mission, due for launch in January 2001, is designed to collect samples of the charged particles in the solar wind and return them to Earth laboratories for detailed analysis. Genesis will return the samples of isotopes of oxygen, nitrogen, the noble gases, and other elements to Earth in 2003. Such data are crucial for improving theories about the origin of the Sun and the planets, which formed from the same primordial dust cloud.

The Comet Nucleus Tour (CONTOUR) mission, with an expected launch in June 2002, will dramatically improve our knowledge of key characteristics of comet nuclei and will allow us to assess their diversity. The spacecraft will leave Earth orbit, but stay relatively near Earth while intercepting at least three comets. The targets span the range from a very evolved comet (Encke) to a "newer" comet such as Hale-Bopp.

In July 1999, two new Discovery missions were selected, Deep Impact and MESSENGER, and in October 1999, the first Discovery Mission of Opportunity, ASPERA-3, was approved for implementation. Deep Impact is designed to fire an 1,100-pound (500 kilogram) copper projectile into the comet P/Tempel 1, excavating a large crater more than 65 feet (20 meters) deep, in order to expose it's the comet's

pristine interior ice and rock. Prior to impact, the projectile will relay close-up images of the comet's surface back to the flyby spacecraft for downlink to Earth. Optical and infrared instruments on the flyby spacecraft will image and spectrally map the impact and resulting crater. Launch is scheduled for January 2004 and the comet impact will occur in July 2005.

The Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) mission will send an orbiter spacecraft carrying seven instruments to globally image and study the closest planet to the Sun. Launch is expected in 2004.

Mars Surveyor Program \$326.7 million

The primary objective of the Mars Surveyor Program is to further our understanding of the atmosphere, surface and subsurface composition and structure, biological potential and possible biological history of Mars, and to search for indicators of past and/or present life there.

In light of the failed Mars Climate Orbiter (MCO) and Mars Polar Lander (MPL), the entire Mars Surveyor Program, including the 2001 Mars Surveyor Orbiter and Lander, is undergoing major re-planning activity. The FY 2001 Budget provides additional funding in this line, above last year's runout projections, to support development and deployment of concepts at Mars that could enhance the science return and overall success of future missions. Detail on the revised schedules and outputs will be provided once the re-planning is completed.

As part of the replanned program, the Office of Space Science envisions that Mars Micromissions and a Mars telecommunications network will be key elements of the Mars Surveyor Program. Mars Micromissions and Mars Telecom Network will enhance the science return from Mars missions by utilizing micro-spacecraft launched as secondary payloads on commercial French Ariane-V geosynchronous transfer missions.

- * Mars science micromissions will be competitively selected under an open Announcement of Opportunity (AO) process with cost cap, to provide low-cost access to Mars for the science community.
- * Mars Telecom Network will support other Mars missions by: 1) Developing a communications capability to provide a substantial increase in data rates and connectivity from Mars to Earth; (2) Developing an in-situ navigation capability to enable more precise targeting and location information on approach and at Mars. Mars Network's increased data rates and connectivity, would enable greater information flow to the public for the purpose of engaging them in the Mars exploration adventure. In essence, Mars Network would be building a publicly accessible "gateway" to Mars.

Mission Operations \$80 million

The goal of the Mission Operations program is to maximize the scientific return from NASA's investment in spacecraft and other data collection sources. The Mission

Operations effort is fundamental to achieving the goals of the Office of Space Science program because it funds the operations of the data collecting hardware that produces scientific discoveries. Funding supports satellite operations during the performance of the core missions, plus extended operations of selected spacecraft. The science community both inside and outside of NASA regularly reviews the mission operations program to ensure that only the missions with the highest science return are funded.

We are launching smaller spacecraft, and engaging in more international collaborations. As a result, NASA expects to be able to support an increasing number of operational spacecraft through FY 2001 despite a smaller MO budget. In total, at the end of FY 2001, we will have approximately 27 operational Space Science spacecraft, in addition to participation in the operations of 12 foreign spacecraft. This compares to 18 operating spacecraft at the beginning of FY 1995. As of the end of January 2000, we have 26 operational missions (29 spacecraft), in addition to participation in the operations of 7 foreign spacecraft.

Missions expected to begin operations before the end of FY 2001 include: HETE-II (6/00), Astro-E (2/00), IMAGE (02/00), Cluster-II (06/00), HESSI (07/00), GP-B (9/01), TIMED (fall/00), MAP (11/00), Genesis (01/01), 2001 Mars Chemical Mapper (03/01), Catsat (07/01), Integral (09/01), and GALEX (09/01).

Supporting Research And Technology \$1.303 billion

	(Millions of dollars)
Technology Program	\$740.3
Research Program	\$523.6
Suborbital	\$38.9

The Space Science Enterprise's Supporting Research and Technology program is comprised of three major components: the Technology program, the Space Science Research program (consisting of Research and Analysis and Data Analysis) and the Suborbital program.

TECHNOLOGY PROGRAM

The goals of the Technology Program are to: (1) lower mission life-cycle costs; (2) develop innovative technologies; (3) develop and nurture an effective science-technology partnership; (4) stimulate cooperation among industry, academia, and government; and (5) identify and fund the development of important cross-Enterprise technologies.

In the Technology Program, the Intelligent Systems Program has a goal to provide NASA with autonomous and semi-autonomous computational capabilities to enable future missions in deep space, planetary exploration, aerospace applications, and Earth observing systems and data understanding. Self-sustaining networks of robotic explorers in future NASA missions will require intelligent systems technologies far more advanced than current Government or commercial capabilities. Many future missions in all NASA Enterprises will require autonomous robotic systems capable of

cooperative behaviors, near-real-time learning, self-healing/self-diagnosis, and on-board decision making.

The FY 2001 budget includes an augmentation to the Space Science budget for Nanotechnology (\$5 million). NASA will participate in the National Nanotechnology Initiative by pursuing fundamental investigations in quantum effects, atom imaging and manipulation, nanotube research, and other related areas. These investigations are expected to lead to applications such as : lighter, smaller, and more capable spacecraft; biomedical sensors and medical devices; powerful, small, low-power computers; radiation-hard electronics; thin-film materials.

The largest component of the Technology Program is the Focused Programs (\$424.5 million). Focused Programs are dedicated to high-priority technologies needed for specific science missions. An aggressive technology development approach is used that allows all major technological hurdles to be cleared prior to a science mission's development phase. Technology activities can encompass developments from basic research all the way to infusion into science missions. Focused Programs also includes mission studies -- the first phase of the flight program development process. Scientists work collaboratively with technologists and mission designers to develop the most effective alignment of technology development programs with future missions. This collaboration enables intelligent technology investment decisions through detailed analysis of the trade-offs between design considerations and cost. In order to ensure that the decisions resulting from mission studies are realistic and can be implemented, the studies will employ new techniques for integrated design and rapid prototyping.

The FY 2001 budget estimate includes four categories of activities under focused programs. These categories correspond to the four scientific themes of the Space Science Enterprise: Astronomical Search for Origins, Advanced Deep Space Systems Development (Solar System Exploration), Sun-Earth Connections, and Structure and Evolution of the Universe. These elements are described below:

- Astronomical Search for Origins Technology develops critical technologies for studies of the early universe and of extra-solar planetary systems. Included are large lightweight deployable structures, precision metrology, vibration isolation and structural quieting systems, optical delay lines and large lightweight optics. Missions supported in this area include the Space Interferometry Mission (SIM), Next Generation Space Telescope (NGST), and Terrestrial Planet Finder (TPF), as well as the provision of interferometry capability to the ground-based Keck telescopes.
- Advanced Deep Space Systems Technology provides for the development, integration, and testing of revolutionary technologies for solar system exploration. Emphasis is on micro-avionics, autonomy, computing technologies, and advanced power systems. Funding is included in this line for the Center for Integrated Space Microsystems and the Advanced Power System project. Funding in this area supports a Europa orbiter and a Pluto/Kuiper Express mission. Technology developed in this area also supports Solar Probe (a Sun-Earth Connections

mission), which shares a significant amount of technology with Europa Orbiter and Pluto/Kuiper Express.

- Sun-Earth Connections (SEC) Technology develops the technologies necessary for missions focused on observing the Sun and the effects of solar phenomena on the space environment and on the Earth. Technology funded in this area supports missions now under study such as STEREO, Solar-B, and Solar Probe, as well as future SEC missions.

The FY 2001 budget includes an augmentation for the Living With a Star Initiative (\$20 million in FY 2001), discussed earlier.

- Structure and Evolution of the Universe Technology provides for the development of technologies to study the large-scale structure of the universe, including the Milky Way and objects of extreme physical conditions. SEU missions are aimed at explaining the cycles of matter and energy in the evolving universe, examining the ultimate limits of gravity and energy in the universe and forecasting our cosmic destiny. Technology funded in this area supports missions now under study, such as FIRST and GLAST, as well as future missions, particularly Constellation-X.

RESEARCH PROGRAM

The Space Science Research Program is made up of two components: Research and Analysis and Data Analysis.

The goals of the Space Science Research and Analysis Program are: (1) to enhance the value of current space missions by carrying out supporting ground-based observations and laboratory experiments; (2) to conduct the basic research necessary to understand observed phenomena, and develop theories to explain observed phenomena and predict new ones; and (3) to continue the analysis and evaluation of data from laboratories, airborne observatories, balloons, rocket experiments and spacecraft data archives. In addition to supporting basic and experimental astrophysics, space physics, and solar system exploration research for future flight missions, the program also develops and promotes scientific and technological expertise in the U.S. scientific community.

The goal of the Space Science Data Analysis program is to maximize the scientific return from our space missions, within available funding. The Data Analysis program is the source of the enormous scientific return generated from our investments in space hardware. Besides scientific advancements, the Data Analysis program also contributes to public education and understanding through media attention and our own education and outreach activities.

The principal goal of the Suborbital program is to provide frequent, low-cost flight opportunities for space science researchers. The program allows these scientists to fly payloads to conduct research on the Earth's ionosphere and magnetosphere, space plasma physics, astronomy, and high-energy astrophysics. Aircraft, balloons and sounding rockets provide access to the upper limits of the Earth's atmosphere. The

program also serves as a technology testbed for instruments that may ultimately fly on orbital spacecraft, thus reducing cost and technical risks associated with the development of future space science missions. It is also the primary opportunity for training graduate students and young scientists in hands-on space flight research techniques. FY 2001 plans call for 26 worldwide balloon missions and 25 worldwide sounding rocket missions.

February 2000